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RESULTS OF THE INVESTIGATION OF THE OTOLITH FUNCTION IN MANNED SPACE FLIGHTS

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Translation of "Rezul'taty issledovaniya otolitovoy funktsii pri pilotiruyemtkh kosmicheskikh poletakh",
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16. Abstract

The study of the effects of conditions of long-term and short-term space flights on the otolith function of cosmonauts.

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RESULTS OF THE INVESTIGATION OF THE OTOLITH FUNCTION IN MANNED SPACE FLIGHTS

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Many opinions and hypotheses have been presented on the cause of origin of the vestibulovegetative complex of symptoms and illusions of spatial position during space flight. The leading significance in the development of the indicated complex of symptoms is attributed to the unusual functioning of the vestibular analyzer, and the otolith apparatus in particular.

Studies of otolith functions in humans under conditions of experimental short-term weightlessness are unanimous (Ye. A. Yuganov et al., 1965; Roman et al., 1963). A repression of the otolith reflex during the period of initial action of weightlessness was noted. In the literature accessible to us, we have not found any publications dealing with the state of the human otolith apparatus after space flight.

The purpose of this research was the study of the effects of conditions of long-term (30 and 96 days) and short-term (up to 7 days) space flights on the otolith function of cosmonauts. This report examines materials from the examination of members of space flight crews of the "Soyuz-21" "Salyut-5" (30 days), "Soyuz-26" -- "Salyut-6" (96 days), and the "Soyuz-22" and "Soyuz-28" (7 days each) manned space flights.

According to data of pre-flight clinico-physiological examinations, all cosmonauts with the exception of cosmonaut V. Bykovskiy, the commander of the "Soyuz-22" space flight, were certified in good health, without any specifics

on the condition of their otorhinolaryngological organs. In this cosmonaut, a congenital high vestibulovegetative stability was noted in the course of repeated complex examinations.

The intensity of the otolith reflex was determined by the antirotation angle of the eyeball with the deviation of the body in a frontal plane. Of the numerous existing methods of registering this reflex (Graybiel et al., 1959; Miller, 1962; Jongkees, 1966; Nelson et al., 1971) we selected for the basis of our study the Fischer method (1930), the application of which does not require anesthesia of the conjunctiva or marking the cornea. This method, which has become widespread in clinics abroad (Vit, 1950; Fluur, 1975), is based on determining the antirotation angle of the eyeball with the aid of visual afterimage when going from a vertical position to a horizontal one.

The device which we constructed consists of a rectangular camera with a vertical slit, a photographic flash mounted inside the chamber, and a separate disk mounted on a stand and graduated into 360^0 with 1^0 divisions. A moveable arrow with handle is attached to the disk.

The test is conducted in a dark room in two stages. In the first stage, the rectangular camera with slit is placed in front of the subject who is seated on a couch. After the flash, an after-image appears on the retina in the form of a bright vertical line. At the second stage, the subject is slowly brought to a horizontal lateral position in which he must remain immobile for a period of 25 - 30 sec in order to record ampular reflexes. Then the subject opens his eyes and places the arrow on the graduated disk

parallel to his visual image. The test is repeated at least 3 times. The angle of deviation of the arrow from the horizontal initial position constitutes the antirotation angle of the eyeball. /22

In connection with the disparity of information in the literature and differences in devices, norms of otolith reflex in 75 somatic healthy males without pathology of the otorhinolaryngological organs or the nervous system were determined for our device. The age of test subjects ranged from 25 to 40 years. Average values of antirotation angle of the eyeball in adults (in degrees) comprised: on the right side $\bar{X} \pm m = 12 \pm 1.07$, $\sigma = \pm 8.4$, on the left side respectively 13 ± 1.02 and ± 8.2. The value of dispersion of physiological asymmetry $(\Delta \pm \sigma)$ was equal to 3 ± 1.7.

During background studies, indicators of otolith reflex intensity for all cosmonauts, with the exception of commanders of the space flight "Soyuz-22" and the space station "Salyut-6" were within the physiological norm established for this device. The otolith reflex, as a rule, was symmetrical, and if any asymmetry was noted, its value did not exceed the boundaries of the physiological norm. In the commander of the "Salyut-6" station, the value of otolith reflex asymmetry (background data) exceeded the physiological dispersion (on the right side by 2° and on the left side by 10°). In the commander of the "Soyuz-22" flight, the otolith reflex was clearly reduced ($1 - 2^{\circ}$) but symmetrical. Evidently the reduction of the otolith reflex in this case may be associated with a congenital high vestibular stability of this cosmonaut. A similar reduction in otolith reflex in vestibularly stable individuals was noted by us earlier during massive vestibulometric studies.

An analysis of in-flight observations showed that certain cosmonauts noted the development of illusory and vegetative reactions. However, the process of adapting to conditions of weightlessness were individual. Thus, all the cosmonauts (with the exception of the commander of the "Soyuz-22" flight) reported that upon entering weightlessness, they immediately got the feeling of their body being turned upside down (inversion illusion). The duration of illusory reactions varied from several minutes to several hours. Then in some cosmonauts as a background either to illusory reactions or to the developing feeling of blood rushing to the head, varying degrees of expressed feeling of vestibular discomfort arose and were intensified during movement of the head and body. Episodic occurrences of illusory reactions and the phenomenon of vestibular discomfort did not cease for the duration of the entire period of adaptation to conditions of weightlessness. The intensity and duration of these reactions was varied.

The cosmonauts of the space ship "Soyuz-22" and the commander of the "Soyuz-28" endured their 7-day flight well, without any vegetative reactions whatsoever. However, these cosmonauts noted the appearance of a feeling of blood rushing to the head after 30 - 40 min of weightlessness. The feeling of blood rushing to the head was accompanied by a development in puffiness of the face, smoothing of wrinkles, and insignificant nasal congestion during breathing.

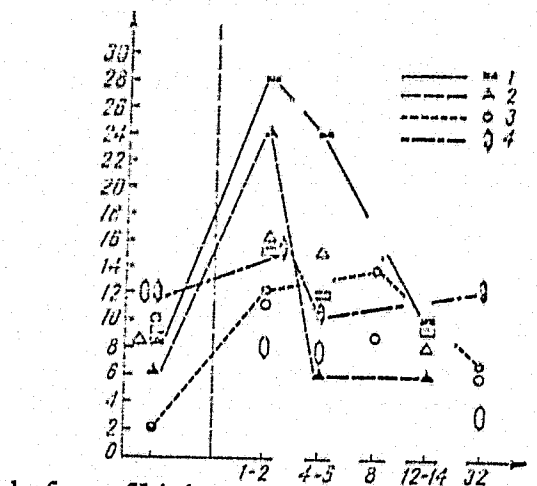
Post-flight examinations of members of flight crews taking part in long-term flights were conducted on the 2, 4-5, 8, 12-14, and 32nd days; for crews of short-term flights -- on the 1, 3-4, and 12th days. In the first days after long-term flight, a sharp degree of expression in otolith stimulation was noted in the cosmonauts -- bilateral hyperreflexia (see figure).

The intensity of otolith reflex in members of the "Salyut-5" station flight crew grew by 2½ - 3 times as compared with the background data. In members of the "Salyut-6" flight crew, increased intensity of the otolith reflex was less pronounced as compared with that in the previous flight and corresponded to the upper limit of the norm.

Along with an increase in otolith reflex in the first days after the flight, all cosmonauts taking part in lengthy flights showed a noted appearance of asymmetry due to hyperreflexia when placed on their right side. /23 The intensity of the reflex with placement on the right and left sides varied from 8 to 13° ($\Delta D > S$ by 8 - 13°). During this period the cosmonauts experienced statokinetic disruptions in the form in instability in Romberg's station and swaying to the right during walking. On the 4th and 5th days after the flight, the asymmetry in otolith function remained. However, there was an apparent tendency toward reduction in the intensity of this reflex. Subjective complaints on the disruption of statokinetics remained. By the 12-14th days after the flight, the value of the otolith reflex in flight crew members who flew for 30 days practically reached the background data, and statokinetic disruptions were not noted in this period. In cosmonauts who were in flight for 96 days, asymmetry of the otolith reflex remained for the first month after the flight, and in the flight engineer there was even noted an increase in it during examination on the 32-nd day. For a month, these cosmonauts also exhibited disruptions in statokinetics.

In studying the otolith functions of cosmonauts after short-term flights, there was not the unidirectionality of reactions which was exhibited after long-term flights. Thus, in the commander of the "Soyuz-22" ship and the flight engineer of the "Soyuz-28"ship, the intensity of the otolith reflex

for the duration of the entire period of examination after the flight corresponded to the background data. In the flight engineer of the "Soyuz-22", an insignificant reduction in otolith reflex was registered after the flight, as well as retention of physiological asymmetry, which was also noted before the flight. The commander of the "Soyuz-28" showed an increase in otolith reflex and asymmetry due to hyperreflexia in a position on the left side. Statokinetic disruptions after short-term flights were noted only in members of the "Soyuz-28" crew. These disruptions practically disappeared by the end of the first week after their return.



The dynamics of otolith reflex before and after flight.

By abscissa axis -- time before and after flight in days; by ordinate axis -- antirotation angle of eyes in degrees.

Otolith reflex indicators: 1- commander of "Salyut-5" station; 2 - flight engineer of "Salyut-5" station; 3 - commander of "Salyut-6" station; 4 - flight engineer of "Salyut-6" station. Dark figures correspond to indicators when positioned on the right side, light figures -- on the left side.

Thus, the study of the otolith function before and after space flight allowed clarification of the individual character of changes in the otolith reflex in crew members developed under the influence of flight factors; the increase in intensity of otolith reflex and the presence of asymmetry in indicators of the studied function after long-term flight; large changes in terms of expression and duration in indicators of otolith function after long-term flight as compared with short-term flight; the possible interdependence between statokinetic disruptions with asymmetry of the otolith function and increase in the otolith reflex, since this same tendency was observed in the development of reactions of the indicated systems.

LITERATURE

1. Yuganov Ye. M., Gorshkov A. I., Kas'yan I. I. et al. Izv. AN SSSR. Seriya biol, 1965, No. 6, p. 877 - 883.
2. Roman, J., Warren B., Graybiel A. Aerospace Med., 1963, v. 34, p. 1085-1089
3. Graybiel A., Naellner R. Am. J. Ophthal., 1959, v. 47 p. 349
4. Fischer F. Albrecht a. Graefes Arch. Ophthal., 1930, v. 123, p. 509.
5. Miller E. Acta oto-oaryng. (Stockh.), 1962, v. 54, p. 479-501.
6. Jongkees L. Ann Otol. (St. Louis), 1966, v. 75, p. 764-771.
7. Nelson J., Cope D. Arch. Otolaryng, 1971, v. 94, p. 40 - 50.
8. Fleuer E. Acta oto-laryng. (Stockh.), 1975, v. 79, p. 111 - 114.